

and Orono, Maine; Traverse City, Marquette, and Escanaba, Michigan; Duluth, Minnesota; Poplar River, Montana; Newport, Vermont; Delavan, Embarras, Lancaster, Wausau, and Prairie du Chien, Wisconsin.

29th.—Marquette and Escanaba, Michigan; Poplar River, Montana.

30th.—Escanaba, Michigan; Monticello, Iowa.

31st.—Dale Enterprise, Wisconsin.

CHART OF ELECTROMETER READINGS.

[Prepared under the direction of Prof. T. C. MENDENHALL, Assistant.]

Observations have been made during the month of October, 1886, at the six stations having the necessary apparatus. At Washington City several sets of simultaneous observations have been made at the Signal Office and at the top of the Washington Monument. The curves obtained on October 4th, a clear, pleasant day, with a light, dry fog in the morning, may be taken as illustrative of the difference in values obtained, under such conditions of weather, at the two places. At the Monument, feeble sparks could be obtained, on connecting the ground with the needle, when the deflection indicated over 700 volts. The observations in this, as in all the other series of simultaneous observations at these places, are taken at intervals of five minutes, except between 1 and 2 o'clock, when they are taken at minute intervals. October 5th was likewise a clear day, with light northeasterly winds. The values at both stations were approximately but half of those obtained on the preceding day. A feeble spark could be obtained when the potential indicated exceeded 455 volts. October 7th was also a day like the others. The values are much higher than those obtained on the 5th, but somewhat less than those of the 4th. The potential at the Monument averages for these dates 300 volts higher than the lower station. This value is less than that usually given. The following abridged table will serve to show, roughly, the differences on the three dates, as well as the correspondence between the two stations:

Time.	October 4.		October 5.		October 7.	
	Monument.	Signal Office.	Monument.	Signal Office.	Monument.	Signal Office.
	Volts.	Volts.	Volts.	Volts.	Volts.	Volts.
9 a. m.		+186		+102		+132
10 a. m.		228		126		138
11 a. m.		96		108		114
11.30 a. m.		198		114		120
12 m.	+595	168	+280	36	+368	120
12.05 p. m.	700	150	420	102	385	126
12.10 p. m.	700	162	420	90	438	114
12.15 p. m.	560	216	420	102	455	126
12.20 p. m.	648	180	420	102	385	84
12.25 p. m.	560	204	455	108	455	84
12.30 p. m.	525	192	525	72	455	84
12.35 p. m.	525	246	455	30	420	102
12.40 p. m.	560	252	420	114	455	96
12.45 p. m.	420	234	350	114	455	102
12.50 p. m.	735	222	297	108	350	108
12.55 p. m.	700	198	280	126	455	114
1 p. m.	543	174		102	490	102
1.01 p. m.	543	120		108	490	114
1.02 p. m.	508	174		102	490	120
1.03 p. m.	508	198		102	490	108
1.04 p. m.	490	180		60	490	114
1.05 p. m.	490	204	385	102	508	102
1.06 p. m.	508	198	385	120	490	114
1.07 p. m.	490	192	350	108	455	84
1.08 p. m.	525	180	260	114	455	90
1.09 p. m.	560	162	315	132	420	114
1.10 p. m.	595	162	350	144	438	120
1.11 p. m.	560	186	333	138	420	102
1.12 p. m.	578	204	350	132	438	108
1.13 p. m.	560	234	350	144	455	102
1.14 p. m.	560	234	350	150	473	108
1.15 p. m.	560	234	315	144	455	102
1.20 p. m.	350	186	280	120	473	108

Time.	October 4.		October 5.		October 7.	
	Monument.	Signal Office.	Monument.	Signal Office.	Monument.	Signal Office.
	Volts.	Volts.	Volts.	Volts.	Volts.	Volts.
1.25 p. m.	560	156		60	455	120
1.30 p. m.	630	222	337	108	438	120
1.35 p. m.	630	150	298	138	490	102
1.40 p. m.	525	210	280	96	473	138
1.45 p. m.	630	174	280	102	455	120
1.50 p. m.	525	174	210	126	455	114
1.55 p. m.	525	240	245	132	420	102
2 p. m.	595	210	245	114	403	96
2.05 p. m.	840	216	210	90	403	102
2.10 p. m.	560	294	175	114	403	132
2.15 p. m.	770	162	245	120	455	132
2.20 p. m.	840	150	210	72	438	102
2.25 p. m.	700	138	245	72	385	126
2.30 p. m.	595	132	315	84	455	108
2.35 p. m.	735	138	315	30	455	114
2.40 p. m.	665	150	280	84	438	108
2.45 p. m.	525	234	245	84	455	108
2.50 p. m.	490	168	245	66	490	126
2.55 p. m.	472	174	245	84	455	126
3 p. m.	525	114	245	90	438	114

On October 14th, after a long spell of dry weather, cloudy weather, with brisk easterly winds and threatening rain, prevailed. The values obtained at the Monument and the Signal Office on this date agree closely in character and degree, although much less in degree than those usually obtained. These values are represented in the first diagram of chart number vi.

The second diagram represents the results of the observations made at Boston, Massachusetts, during the month, the numbers corresponding to dates. The third diagram gives the results of the observations made at New Haven, Connecticut.

At Baltimore, Maryland, a continuous photographic record has been obtained. The following notes are abstracted from the observer's report: During October 14-15th stratus clouds covered the sky until about 6.30 a. m. of the 15th. The potential indicated is abnormally low, until the disappearance of the clouds, when it increases rapidly. During rainfall on several occasions the curves show decided variation. A curve characteristic of fair weather with upper clouds is shown by the records of the 17th and 18th. A variation synchronous with a change in wind direction appears on October 18th from 3 to 7 p. m., the wind having changed from sw. to ne., backing through the south points.

At New Haven, Connecticut, negative indications occurred on October 18th, at the 9 a. m. observation, during heavy rain; at 3 p. m. on the 21st, during clear weather, although it had rained during the forenoon; at 9 a. m. of the 26th, during threatening weather, and on the 27th, during heavy rain. Rain with positive values occurred but once, on October 28th, at 3 p. m. The highest values were obtained on October 1st, during clear weather and light northwest winds, and on October 4th, during clear weather and light southwest winds. The lowest values were on October 27th, 11th, and 26th, during rainy weather. The values nearest zero occurred on October 7th, during clear, somewhat hazy weather, with northeasterly winds.

At Boston, Massachusetts, a complete set of observations has been made. On October 2d variations in the potential were noticed at times corresponding with the passage of certain cumulo-stratus clouds. A thunder-storm, with hail, occurred at midnight of the 30th. Negative indications were given on October 4th, at 11 a. m., when there were no clouds, and a fresh west wind was blowing. Negative indications were also observed on the 15th at 11 a. m., during fair weather, following rain; on the 21st, at 11 a. m., during fair weather, with the wind northwest and brisk; on the 28th, at 11 a. m., with threatening weather, and at 3 p. m. of the 31st, preceding by more than an hour, light rain. Rain occurred without negative values on the 27th, 28th, and on the 29th and 30th,

when, however, the values are very low positive. October 14th shows the greatest variation for any one date, and in less marked degree, October 24th.

At Columbus, Ohio, large negative values were obtained on October 4th, during the passage of heavy cumulo-stratus clouds, moving slowly from the southwest, with a slight rain during the night. On October 27th, during light rain, the values were nearly zero. Rain during the night of the 26th was preceded by very low values during the day. The highest positive values were obtained on the 8th and 11th.

At Ithaca, New York, negative values were recorded on October 5th, at 9 a. m., during dense haze. On October 14th, during threatening weather, with high southerly winds, throughout the entire day. On October 17th, at 1 and 3 p. m., following light snow, during which the indications were positive, high negative values were obtained. On October 26th, during threatening weather, and on October 27th, during fog, negative values were obtained. No rain is recorded during the beginning of the month until October 12th, and, with the exception of October 5th, when haze is noted, there were no negative indications for this part of the month. A light rain occurred on the 12th, and a light shower on October 15th, with positive values. Fog and rain on the night of the 27th and morning of the 28th, although preceded by negative and low positive values, were accompanied by high positive values. The highest values obtained were on October 23d, at the last three observations, during clear weather, with fresh, westerly winds; on October 28th, in the morning, during fog and light rain, and on October 12th, in the afternoon, during haze, with light westerly winds.

OPTICAL PHENOMENA.

SOLAR HALOS.

Solar halos were observed in the various states and territories, as follows:

- Arizona*.—Fort Apache, 19th.
- Arkansas*.—Little Rock, 21st.
- California*.—San Francisco, 15th, 18th, 19th, 24th, 25th, 28th; Sacramento, 24th.
- Connecticut*.—North Colebrook, 4th.
- Florida*.—Archer, 1st, 2d, 9th; Jacksonville, 8th.
- Georgia*.—Savannah, 3d.
- Idaho*.—Boisé City, 9th, 26th.
- Illinois*.—Riley, 3d, 6th, 11th, 12th, 20th, 22d; Springfield, 3d, 9th.
- Indiana*.—Butlerville, 14th.
- Indian Territory*.—Fort Reno, 25th.
- Iowa*.—Keokuk, 22d.
- Kansas*.—Independence and Westmoreland, 3d; Globe, 3d, 11th, 21st; West Leavenworth, 3d, 21st.
- Kentucky*.—Frankfort, 25th.
- Massachusetts*.—Blue Hill Observatory, 17th.
- Michigan*.—Marquette, 2d, 7th.
- Minnesota*.—Moorhead, 2d.
- Missouri*.—Centreville, 3d.
- Montana*.—Fort Custer, 4th, 29th.
- Nebraska*.—Brownville, 21st.
- Nevada*.—Carson City, 23d, 28th.
- New Jersey*.—Clayton, 4th, 6th, 17th.
- New York*.—Oswego, 4th.
- North Carolina*.—New River Inlet, 8th, 10th, 11th, 13th, 17th, 20th, 26th; Fort Macon, 10th.
- Ohio*.—Wauseon, 3d, 12th; Tiffin, 17th.
- Oregon*.—Roseburg, 26th.
- Pennsylvania*.—Wellsborough, 3d, 26th; Dyberry, 4th.
- South Carolina*.—Stateburg, 3d, 10th, 17th, 21st.
- Tennessee*.—Chattanooga, 4th; Nashville, 4th, 9th, 10th, 25th.
- Utah*.—Frisco, 20th, 28th.
- Virginia*.—Variety Mills, 1st, 4th; Lynchburg, 4th; Cape Henry, 10th, 26th; Dale Enterprise, 10th, 17th, 31st.
- Wisconsin*.—Delavan, 11th.

LUNAR HALOS.

Lunar halos were observed in the various states and territories, as follows:

- Alabama*.—Mobile, 6th, 12th.
 - Arizona*.—Fort Apache, 2d, 28th; Yuma, 8th; Prescott, 9th; Fort Thomas, 10th.
 - California*.—San Diego, 10th; Red Bluff, 14th.
 - Colorado*.—Las Animas, 6th.
 - Connecticut*.—New Haven, 4th; New London, 4th, 8th.
 - Dakota*.—Bismarck, 7th.
 - Florida*.—Cedar Keys, 4th, 5th, 6th; Limona, 6th; Sanford, 7th; Key West, 7th, 10th, 11th, 12th; Jacksonville, 8th; Archer, 8th, 9th; Pensacola, 9th; Manatee, 10th, 11th, 15th.
 - Georgia*.—Savannah and Augusta, 9th.
 - Illinois*.—Springfield, Cairo, and Pekin, 3d; Riley, 11th, 13th, 17th; Windsor, 3d, 12th.
 - Indiana*.—Jeffersonville and Terre Haute, 3d; Fort Wayne, 11th; Butlerville and Lafayette, 13th.
 - Iowa*.—Dubuque, Cedar Rapids, and Urbana, 11th; Clinton, 12th, 17th; Manchester, 16th.
 - Kansas*.—El Dorado, Independence, and Westmoreland, 3d; Wyandotte, 3d, 7th, 8th, 9th, 14th; Leavenworth, 8th; Salina, 31st.
 - Kentucky*.—Frankfort, 3d, 7th.
 - Maine*.—Gardiner, 4th; Cornish, 4th, 11th, 12th, 18th.
 - Massachusetts*.—Somerset, 4th, 6th; Cottage City, 5th.
 - Michigan*.—Port Huron, 8th, 11th; Grand Haven, 9th, 11th; Detroit, Lansing, and Thornville, 11th.
 - Montana*.—Fort Custer, 14th.
 - Nebraska*.—North Platte, 4th, 7th; Omaha, 17th; Hay Springs, 18th.
 - New Jersey*.—Atlantic City, Clayton, Dover, and Readington, 4th; Egg Harbor City, 4th, 10th; Beverly, 4th, 6th, 15th; Upper Montclair, 5th.
 - New Mexico*.—Fort Stanton, 2d, 15th.
 - New York*.—Setauket, 4th; Rochester and Oswego, 8th; Factoryville, 9th.
 - North Carolina*.—Weldon, 4th; New River Inlet, 4th, 7th, 9th; Wilmington, 6th; Fort Macon and Smithville, 9th, 10th; Kitty Hawk and Hatteras, 10th; Charlotte, 10th, 16th.
 - Ohio*.—Tiffin, 3d; Napoleon, 10th, 11th, 13th; Wauseon, 11th.
 - Oregon*.—Linkville, 10th; Roseburg, 31st.
 - Pennsylvania*.—Wellsborough, 17th.
 - Rhode Island*.—Block Island, 4th.
 - South Carolina*.—Spartanburg, 1st, 10th, 20th, 21st; Charleston, 9th; Stateburg, 9th, 10th.
 - Tennessee*.—Nashville, 10th.
 - Texas*.—Palestine, 3d; Galveston, 11th; Fort Elliott, 15th.
 - Utah*.—Salt Lake City, 12th.
 - Virginia*.—Cape Henry, 4th, 10th; Bird's Nest, 4th, 5th, 10th, 14th; Rappahannock, 7th, 12th, 16th; Lynchburg, 10th; Dale Enterprise, 10th, 14th, 21st.
 - Washington Territory*.—Tatoosh Island, 9th.
 - Wisconsin*.—Green Bay, 8th; Beloit, 9th to 12th, 14th, 16th; Milwaukee, 12th.
 - Wyoming*.—Fort Bridger, 3d, 15th, 25th to 28th.
- The phases of the moon (Washington mean time) during October, as given in "The American Ephemeris and Nautical Almanac" for 1886, are as follows: New moon, 26th, 14 h. 7.2 m.; first quarter, 4th, 5 h. 25.2 m.; full moon, 12th, 10 h. 15.7 m.; last quarter, 19th, 21 h. 32.6 m.; apogee, 8th, 8.3 h.; perigee, 24th, 6.7 h.

MIRAGE.

Saint Vincent, Minnesota: at 8.10 a. m. of the 29th a well-defined mirage was seen to the south; the image of a range of hills known as the "Ridge," distant twenty-five miles, was lifted into view. The phenomenon was visible until 8.30 a. m. Mirages were also observed on the following dates:

- Webster, Dakota, 21st.
- Salina, Kansas, 7th, 8th, 11th, 27th, 29th.